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THE DYSPEPSIA OF HYPERACIDITY.[1]

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THE physiologic fact that hydrochloric acid is necessary to produce the proteolytic effect of pepsin made it appear, before the chemistry of the stomach was better understood or studied, that in all digestive derangements there would have to be necessarily an absence of either the enzyme or the acid. Since it has been shown that the pepsin of the stomach is probably never absent, the pathology of dyspepsia has been based upon the assumption that the less HCl, the less active the gastric digestion, and *vice versa*. With the quantitative study of the gastric secretions, this assumption was soon dispelled, for, according to Boas, from 50 to 60 per cent. of all dyspepsias are due to an abnormal increase in the hydrochloric acid in the gastric juice rather than to subacidity. This seems almost paradoxic, especially if we consider the fact, also developed, that under the circumstances proteids are well digested, and that the expressed secretion has a high proteo-

[1] Read at a meeting of the J. Aitken Meigs Medical Society, March 9, 1893.

lytic power. In the same measure, however, in which, by an increased HCl acidity, the albuminoids are more readily digested, the conversion of starches into sugar is retarded or even abolished. Thus, we find here the first evidence of a disordered digestion in the interference with the amylolytic process of the stomach.

It has been ascertained by chemical research that the proportion of HCl in the contents of the gastric juice at the height of the digestive process is about 0.25–0.3 per cent. or 2.5–3.0 per mille. This, according to Bunge and others, is about the amount necessary to render the food-bolus aseptic, constituting one of the most important and principal functions of the HCl secreted by the glandular apparatus of the gastric mucous membrane. The fact that dogs whose stomachs had been entirely extirpated lived for over five years, digested, and grew fat, showing not alone a perfect digestion but also assimilation, would bear out the view that the stomach itself, as a vehicle for digestion, is not of as great importance as is usually attached to it. That it is a preparatory receptacle for the food, in which the latter is first of all deprived of the micro-organisms with which all food swarms, and that certain predigestive processes are necessary to insure a subsequent proper pancreatic and intestinal digestion, seems out of question.

To arrive at the etiology of the HCl over-production we find that there are no certain causes save those attributable to the sensory nerves and the reflex action produced by them. While in ordinary gastric digestion the hydrochloric acid will

but slowly develop, following the lactic fermentation, in hyperacidity we can find acidity already developed within 10 minutes after the trial-breakfast, and within from a half to three-quarters of an hour rapidly increased to its highest limit. Thus we see that the irritation of the food on the gastric mucosa, which is considered as the normal cause of the HCl secretion, is abnormally responded to, and that greater quantities are produced and poured out. So much is this the case that the contents of HCl n the gastric juice have been stated in such cases at as much as from 0.4 to 0.5 or 0.6 and even 1 per cent.(?) We see again that the gastric motility is greatly dependent on the HCl present, and that the alkaline mucous membrane of the pyloric portion of the stomach is by it reddened and tumefied, thus lessening the lumen of the pyloric orifice. Pyloritis resulting from hyperacidity is only the first step in hyper-motility, which must necessarily result in ectasis and subsequent incurable atony and atrophy of the gastric mucous membrane. But it is not the remote effect of increased HCl secretion alone that I desire to consider here, but rather the immediate effect upon the digestion, the proper elaboration and assimilation of the food.

The food-bolus of hyperacid digestion is propelled through the pylorus, and already in the pyloric portion of the stomach some neutralization takes place. In the duodenum it meets the alkaline pancreatic and biliary secretions. The digestion there, both of proteids and carbohydrates, is by far greater than can be the case in the stomach. The great proteolytic power of the pancreatic secre-

tion has been experimentally demonstrated. The amylolytic power of the salivary and gastric secretions can be said to be much smaller in proportion to those of the pancreatic fluid. The pancreatic secretions, however, depend for their action upon a distinct alkaline reaction. If the food-bolus of the stomach is of an acidity to neutralize or more than neutralize this, the result must be evident. Intestinal digestion cannot go on, and the food-bolus, in which the micro-organisms were not destroyed but only inhibited from development and propagation, now falls an easy prey to microbic action developing in the partly-neutralized chyme.

The yeast-cells produce alcohol, butyric and lactic acids, with carbonic acid (expelled by frequent and deep eructations), while the proteids, in their decomposition, give rise to ptomaïnes and poisonous gases, the latter readily recognized by the odor of the eructations. The absorption of poisonous material manifests itself by vertigo and headache; the presence of the acids on the intestinal mucous membranes produces hyperemia, swelling, and catarrhal inflammation generally; and while the nutrition is lowered by the abnormal food-decomposition, the catarrhal affection itself, extending over larger and larger surfaces of the intestinal tract, prevents assimilation of such food-material as has been properly elaborated.

The symptomatology of dyspepsia from hyperacid digestion is one that can easily be explained by the pathologic conditions pointed out. The tongue is usually clean, but may also in long-continued conditions become large, coated, flabby, and marked

by the imprints of the teeth. The buccal exhalations are usually fetid, especially after eructations; the teeth exhibit a marked tenderness, and are often found carious; and as hyperacid dyspepsia is preëminently a disease of early life, it accounts for the loss of teeth in that period. The pulse is sluggish and there is marked languor, dulness, and sleepiness; frontal headache and vertigo are frequent. Eructations begin within a few hours after meals, and are usually of a deep guttural character, often also forcing the acid gastric contents into the esophagus and mouth, and causing a burning and acid taste. The eructations at the latter part of gastric digestion frequently contain bile, and have consequently a bitter taste. Vomiting, while not the rule, may under such conditions be frequently noticed. Within an hour or two after eating there will be burning in the epigastrium, increased often to intense gastralgia, felt both anteriorly and beneath the left scapula. The bowels are constipated, the abdomen distended; and at intervals diarrheas with violent colicky pains may occur. The skin soon becomes sallow and the sclera icteroid. The bodily weight diminishes, and the mucous surfaces show the pallor of anemia. The nervous system presents the characteristics of neurasthenia, fatigue, languor and lack of energy, in a marked manner. Slight fever follows usually within a few hours of the ingestion of food, and often continues almost constantly, with alternate rigors and flushed countenance. The appetite, while capricious at first, soon diminishes, and often fails. The ingestion of albuminoids and drinks is generally found to give relief

from the gastric distress; and the signs of subsequent ectasis, with atony and atrophy of the mucous membrane, may follow in the wake of such cases.

The diagnosis of hyperacid dyspepsia can never be based on the anamnesis and symptomatic complex alone. Almost all disturbances of digestion may run a similar course, and, as has been pointed out, very opposite conditions may develop from it. In view of the vast advantages such cases may derive from treatment, and the serious results that may follow misapplied therapy, it is of the greatest importance that an early diagnosis be definitely established. This is possible only by the modern means which have been placed within our reach. The chemical examination of the stomach-contents alone, made at frequent intervals and after the well-established trial-meal, will enable us to define the true condition of the digestive disturbance. This can only be accomplished by means of the stomach-tube. This should be used within an hour, or if possible within half an hour, and again an hour after the trial-breakfast, as proposed by Ewald and Riegel, consisting of from 50 to 100 grams of dry bread washed down with a cup of tea or water. The recognition of the HCl should be relied upon by the phloroglucin-vanillin or the resorcin test, as these will only show the HCl and not organic acids or acid phosphates. The former deserves, perhaps, the preference over the latter. If HCl is found present within from 15 to 30 minutes after ingestion, an indication of hyperacid digestion is already at hand. But even this will not suffice, for the quantitative determination of

the acid will alone justify us in arriving at a conclusion. To this end at least 30 c.c. of the gastric fluid should be expressed through the tube. This should be filtered and the filtered liquid tested for its total acidity. This can be readily done by placing 10 c.c. of the filtered gastric juice in a capsule or flask, to which a few drops of an alcoholic solution of phenolphthaleïn are added. Into this, from a graduated burette, the deci-normal solution of sodium hydrate is allowed to flow, drop by drop, until a slight roseate hue indicates the neutralization of all of the acids.[1]

After the total acidity is thus obtained the total hydrochloric acid is now determined best by Mintz's method.[2]

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[1] A normal solution of sodium hydrate is one that contains as many grammes of NaOH in a liter as is its molecular weight (Na = 23, O = 16, H = 1, total M. W. = 40) *i. e.*, 40 grams to one liter. As the sodium hydrate, owing to its deliquescent nature, is never uniform in strength, it can be practically made by first taking a somewhat stronger solution (45–50 to a liter), and then titrating with it a semi-normal solution of oxalic acid (63 grams crystallized oxalic acid in distilled water, q. s. to 1000 c.c.). This is diluted so that the number of c.c. NaOH solution neutralizes exactly an equal number of the semi-normal oxalic acid solution. Of this normal volumetric sodium hydrate solution, take 10 c.c. and dilute in a 100 c.c. graduated flask with distilled water to 100 c.c., which gives the *deci-normal* solution of sodium hydrate. The measurements of these solutions should be made at 60 F.

[2] This is effected by adding to another 10 c.c. of the filtered gastric juice, one c.c. at a time of the deci-normal sodium hydrate solution. After the addition of each c.c. the fluid has to be stirred and tested with the Günzburg test. To this end a drop or two of the phloroglucin-vanillin solution is dropped into a white porcelain capsule and is well mixed with an equal amount of the gastric juice. By passing the capsule through or over the heat of a lamp the fluid is allowed to evaporate without reaching the

The chemical diagnosis completed, the only features to be considered are those of differentiation. Here we have only two conditions in which hyperacidity supervenes, of which the more frequent is gastroxynsis, in which the hyperacidity is due to a special irritation, such as psychical strain, ingestion of acid and irritant substances, and also very often after smoking, especially of very strong tobacco. This condition is accompanied by supraorbital headache, gastralgia, and epigastric burning, nausea, and finally vomiting of the irritant contents of the stomach. It is relieved by the drinking of dilutents, but as the paroxysms are rather isolated than regularly accompanying or following ingestion of food, and as the exciting causes are usually obvious, the differentiation ought to offer no difficulties.

The other condition is that of hypersecretion, also termed succorrhea. The differentiation of

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boiling-point, whereupon, if HCl is present, a red color, more or less intense according to the amount of HCl present, will appear. When the Günzburg reaction made in this way is getting more and more pale, and finally is absent altogether, the last tenth of a c.c., or rather, the last c.c., plus 0.1, is taken as the one at which the reaction occurred. Both the total acidity and the HC acidity are best expressed as though the test had been applied to 100 c.c. gastric juice. Thus if the total acidity has been indicated by 12 c.c. of the deci-normal soda solution the total acidity should be indicated as 120, and if the total acidity had not been indicated at 10 but after 9.9 c.c. of the deci-normal sodium solution, the HCl acidity should have been noted as 10 or 9.95. As each c.c. of deci-normal soda-solution corresponds to 0.00365 HCl the total HCl in 100 would have been 0.365. The difference between the 120 of total acid and the 10 HCl would then be represented by organic acid and acid phosphates, which, however important they are in subacid conditions, are of little consequence in hyperacid digestion.

this from hyperacidity is comparatively easy if it is borne in mind that it exists in the stomach without the additional irritation or provocation of food or ingesta. It can be found in the empty stomach, especially in the morning, and the fluid can be expressed in quantities of from 100 c.c. to 1000 c.c., and is often vomited in the morning and then known as water-brash. It also has the symptoms of hyperacidity accompanying it, and the gastric juice so freely obtained in these cases contains from 2 to 4 per mille of HCl. A stomach which has been washed out at night, and from which, without taking food during the night, large quantities of hyperacid or even acid gastric juice can be evacuated in the morning, is subject to hypersecretion rather than the characteristic hyperacidity.

That the three neuroses of hyperacidity, gastroxynsis, hypersecretion, and hyperacidity proper, are closely associated and can arise one from the other is no doubt true, but the three are typical and different affections which produce different results, and depend for their amelioration and cure on different treatment. In point of diagnosis I should also mention the condition of the urine in hyperacidity. This is generally found alkaline and deficient in chlorids. As the HCl of the stomach must be derived from the chlorids of the blood and from the action of the acid sodium carbonate on the chlorids, probably according to the following formula:

$$NaHCO_3 + NaCl = Na_2CO_3 + HCl.$$

It will be found that not alone will the blood be deprived of chlorin, but in consequence of the acid

sodium carbonate being converted into the normal sodium carbonate, the blood also becomes more alkaline, and the change of the neutral sodium phosphate of the blood into the acid sodium phosphate of the urine becomes less, if any takes place.

The prognostic features of hyperacidity, as already pointed out, may be such as to promise ready relief, but again some of the severer complications may not only impair health, but threaten life. Thus, if resulting in ulcer, the prognosis is not always favorable, and if pyloritis should result, with consequent ectasis, the impairment of health would certainly be a serious one. The secondary intestinal catarrhal conditions produced by the acid and improperly prepared chyme, and the accompanying malassimilation and malnutrition, are only too well known to need comment. If the sensory disturbance can be known or traced, an improvement of the vicious function may be accomplished, but if chronicity persists it will sooner or later lead to the graver complications already pointed out. It seems only necessary to remark that it affects adolescents more frequently than older persons, and that many so-called cases of chlorosis with obstinate constipation and alkaline urine have their origin in hyperacid dyspepsia.

The treatment of hyperacid dyspepsia is one that must primarily depend on the removal of the etiologic factors. To this end, if arising from a principally sensory neurosis, the nervous system should be toned up by exercise, cold baths, and skin friction, athletics, horseback-riding, and with all a healthy mental occupation. Surf-bathing and ocean

travel often produce a favorable influence when no amount of medication will induce the slightest change. Together with this, dietetics are of importance. The diet, as soon as the character of the digestive derangement is ascertained, should be largely animal, and, contrary to that employed in the lithic diathesis, the darker meats are preferable. They can neutralize more HCl than the white meats. Milk-diet is much recommended in this connection, but is not always borne. The milk curdles readily, and the acid makes the curds firm, which in turn stimulate the gastric mucous membrane to greater secretion. Buttermilk answers this purpose much better, and is generally easily digested. Raw or very soft boiled eggs are the very best diet; also oysters and fish. Vegetables, starches, and sugars are not indicated, and should be avoided. To fill the want of carbohydrates, already partly converted amyloses should be taken, *i. e.*, toast, zwieback, rusks, etc. Buttered toast and milk-toast are among the best carbohydrates and derivatives thereof that can be taken. Coffee and chocolate are not permissible, but tea, on account of its astringent properties, is both well liked and often gives prompt relief to the pyrosis. Broths with raw eggs stirred into them are of advantage. Fats are not contra-indicated, but fried food is strictly so. Amongst all fats butter is the best substitute for the carbohydrates which are to be avoided.

One of the main features of the diet should consist in the absence of salt, salted meat or fish, or saline broths. While by administering more salt we cannot compel the peptic cells to secrete more

HCl, we can starve their vicious secretion into submission by the withdrawal of chlorin compounds. All HCl must necessarily come from the ingested chlorids, and if we diminish these we must certainly diminish the facilities for its production. This is the more the case, as with an almost exclusive animal diet there is but little use for salt.[1]

The mechanical therapy by means of lavage finds here, perhaps, one of its most important uses, not alone that by washing out the stomach with an alkaline fluid the amount of HCl can be neutralized and removed, but by the mechanical action of the current the over-stimulated glands become quieted down and less hyperemic. To this end the stomach should be washed out with several quarts of warm water containing one or two teaspoonfuls of $NaHCO_3$ before the principal daily meal. The medicinal treatment must necessarily be limited to evacuants and correctives. It is customary for the purpose of evacuation to administer Carlsbad salts in the morning while fasting, but as these contain considerable chlorids, which for the reasons given are contra-indicated, I have been in the habit of employing for some time past a mixture of one dram of sodium bicarbonate to one ounce of crystalline sodium sulphate. Of this mixture a heaping teaspoonful or two taken in a glass of hot water before breakfast answers the purpose of an antacid and a mild laxative to excellent advantage. As a corrective I use sodium bicarbonate, but instead of administering it after

[1] Compare Chapter V of Bunge's Lehrbuch der physiologischen und pathologischen Chemie.

food I have for some time past found it much better borne and of greater efficacy if taken some time before meals. The amount of alkali so needed is less; and the stomach, together with the duodenum, becomes neutralized prior to the ingestion of food. The large doses of sodium bicarbonate sometimes recommended are not serviceable, as it is a well-known fact, proved by the equation given, that it is mainly by the conversion of the bicarbonate into the carbonate that the HCl is liberated. For purposes of relieving the pyrosis, magnesia, and especially the milk of magnesia, is preferable to the alkaline carbonate. The bitter tonics answer to excellent advantage in combination with the alkalies, while at times in the nervous excitations sodium bromid may find application. Promiscuous and meddlesome medication is, however, uncalled for and to be deprecated in this affection.